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The binary system was created long before Leibniz

In numerous, and even more recent, writings, the universal scholar Gottfried Wilhelm Leibniz is once again referred to as the discoverer or inventor of the binary system. During his lifetime there was no use for such a system, but since the 1940s it has been an important basis for electronic digital computers. Based on the work of Shirley and Ineichen, the European origin of the positional number system is being touched. There are reports of much older number systems using only two symbols that have been developed mainly in Asia.

First known investigations by Thomas Harriot from England

About 70 years ago, John W. Shirley (North Carolina State College, Raleigh, North Carolina) pointed out that the binary system was created long before Leibniz:

„Though it is frequently stated that binary numeration was first formally proposed by Leibniz as an illustration of his dualistic philosophy, the mathematical papers of Thomas Harriot (1560–1621) show clearly that Harriot not only experimented with number systems, but also understood clearly the theory and practice of binary numeration nearly a century before Leibniz’s time.“ (see John W. Shirley: Binary numeration before Leibniz, American journal of physics, volume 19, 1951, issue 8, page 452).

Shirley rejects Leibniz as the first creator of the binary system. The English mathematician and scientist Harriot had investigated the binary, ternary, quaternary and quinternary system and also higher number systems. However, he did not see any practical application at that time.

Robert Ineichen from the University of Freiburg (Switzerland) notes to Thomas Harriot:

"He is probably the first inventor of the binary system, as several manuscripts in his legacy show. In the binary system, he uses the numerals 0 and 1 and shows examples of how to move from the decimal system to the binary system and vice versa (*conversio* or *reductio*). Using further examples, he demonstrates the basic arithmetic operations (see Robert Ineichen: Leibniz, Caramuel, Harriot und das Dualsystem, Mitteilungen der deutschen Mathematiker-Vereinigung, vol. 16, 2008, issue 1, page 14).

First known publication by Juan Caramuel y Lobkowitz

The two-volume work *Mathesis biceps vetus et nova* by the Spanish clergyman Juan Caramuel y Lobkowitz (1606–1682), published in 1670, probably contains, according to Ineichen, the first known publication in Europe on the binary system (and other place value systems).

Gottfried Wilhelm Leibniz (1646–1716) dealt with this topic in the *Histoire de l'Académie royale des sciences* (Paris, 1705). John Napier discussed binary arithmetic (double powers) on a chessboard (multiplication, division, square root extraction) in his *Rabdologiae* (1617). And Blaise Pascal had recognized in *De numeris multiplicibus* (1654, 1665) that the base 10 is not mandatory.

Binary, ternary and decimal calculators

Leibniz built (mechanical) decimal calculators, one of which is preserved. He also described a binary model working with balls. Some early electromechanical or electronic relay and tube computers were decimal: ENIAC, Harvard Mark/IBM ASCC, Univac (all USA). But the binary representation prevailed: ABC (USA), Edsac (UK), Ferranti Mark (UK), IAS calculator (USA), Pilot Ace (Brit-

ain), Zuse Z4 (Germany). Ternary computers such as Setun (Russia) were rare. A special feature: *quantum* computers can be in two states at the same time.

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